

Chapter 5. Eukaryotic Cells and Parasites

- **Eukaryotic cells**
- **Principles of parasitology**
- **Eukaryotic Parasites**
 - **Protists**
 - **Fungi**
 - **Helminths**
 - **Arthropods**

Prokaryote vs. Eukaryote

- Pro = before
- Eu = true
- Karyon (Greek) = kernel or nucleus

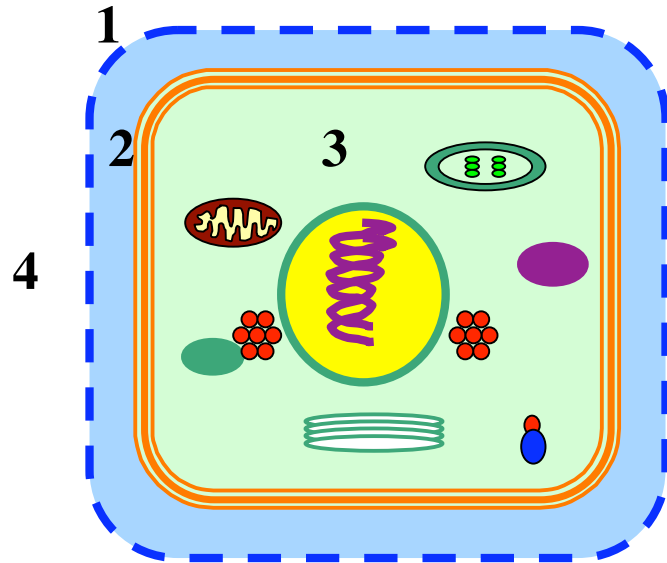
Nucleus. Membrane-bound compartment within a eukaryotic cell containing the genetic material (chromosomes)

- Prokaryotic cell lacks a nucleus and evolved before the eukaryotic cell
- Eukaryotic cell may have evolved from a large prokaryote after it surrounded its DNA with a membrane and then formed an internal symbiotic association with smaller prokaryotic cells

Eukaryotic microorganisms

- **Protozoa, algae, yeast and fungi**
- Table 5-1

Cells are larger and more complex than prokaryotic cells



~5-100 μm

1. Cell wall
2. Cell membrane
3. Cytoplasm and internal structures
4. External structures

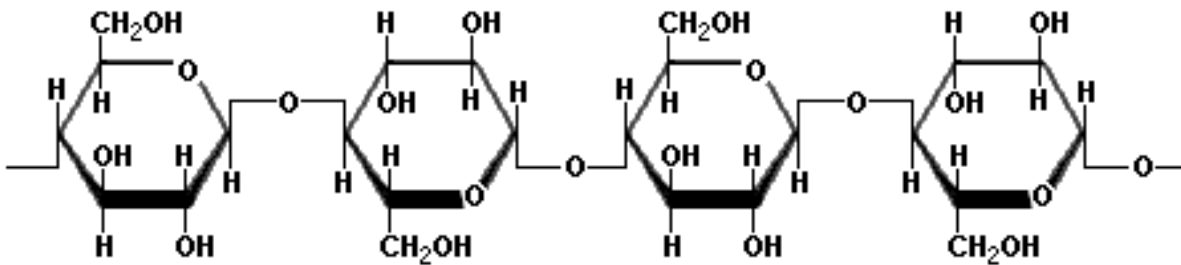
Figure 5-2

1. Cell wall

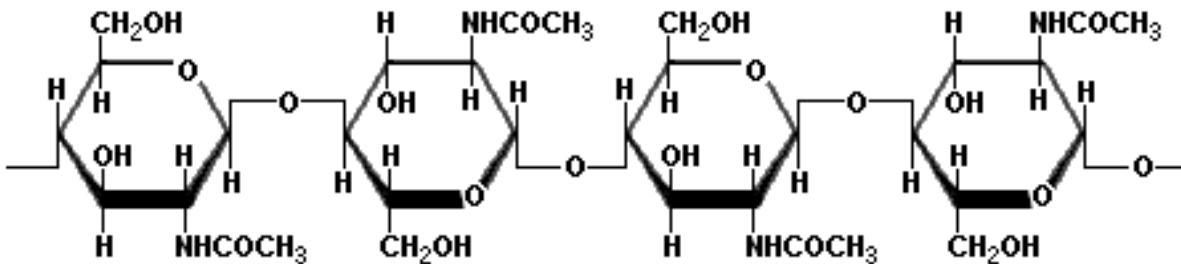
- Peptidoglycan never present (only in prokaryotes)
- Algae have cellulose (polysaccharide)
- Fungi and yeast have cellulose or chitin (polysaccharides)
- Protozoa do not have a cell wall

Polysaccharides in eukaryotic cell walls

Cellulose: polymer of glucose



Chitin: polymer of *N*-acetylglucosamine



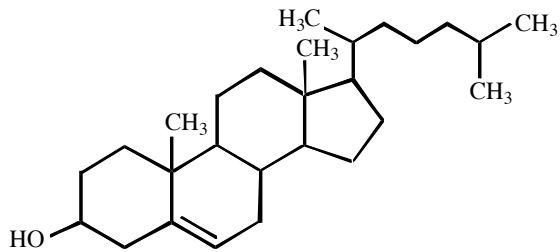
2. Cell membrane

- Similar to that of prokaryotes

Phospholipid bilayer

Embedded proteins

- Also contains sterols that increases membrane stability and rigidity



3. Internal structures –organelles and specialized compartments

-More complex than prokaryotic cells

-Eukaryotic cells also contain membrane-bound organelles that account for 60 – 80% of their volume.

- **Nucleus** Contains chromosomes (DNA) surrounded by nuclear membrane
 - Compact sphere, most prominent organelle of eukaryotic cell
 - Nuclear envelope composed of two parallel membranes separated by a narrow space and is perforated with pores
 - Nucleolus – dark area for rRNA synthesis and ribosome assembly

Figure 5-5

- **Mitochondria**
 - Site of ATP synthesis
 - Function in energy production
 - Consist of an outer membrane and an inner membrane with folds called cristae
 - Cristae hold the enzymes and electron carriers of aerobic respiration
 - Divide independently of cell
 - Contain DNA and prokaryotic ribosomes

Figure 5-11

- **Ribosomes** Site of protein synthesis

Larger than prokaryotic ribosomes

Composed of rRNA and proteins

Scattered in cytoplasm or associated with RER

Chloroplasts Site of photosynthesis in algae and other photosynthetic eukaryotes

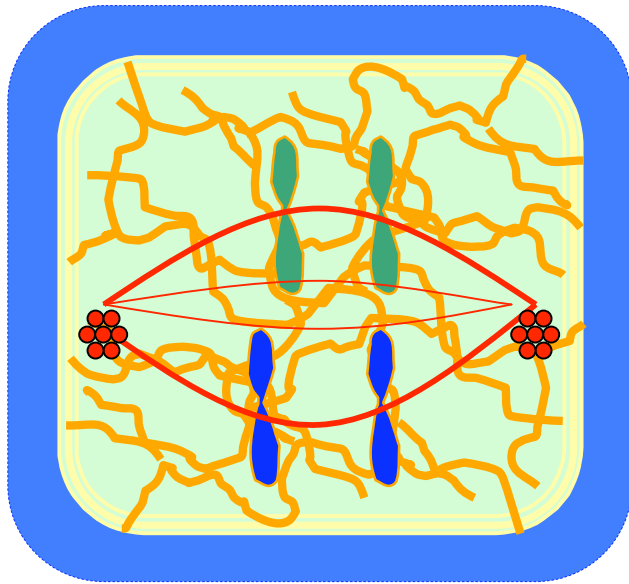
- Convert the energy of sunlight into chemical energy through photosynthesis
- Found in algae and plant cells
- Outer membrane covers inner membrane folded into sacs, thylakoids, stacked into grana
- Larger than mitochondria
- Contain photosynthetic pigments
- Primary producers of organic nutrients for other organisms

Figure 5-12

- **Cytoskeleton**

- Network of protein fibers and tubes in cytoplasm
- Supports cell structure and provides a scaffold for movement of various intracellular components

Ex. chromosomes during cell division



Centrioles
Spindle fibers

• **Internal membrane-bound compartments**

1. Endoplasmic reticulum

- Site of synthesis of lipids and secreted proteins
- Rough endoplasmic reticulum (RER) – originates from the outer membrane of the nuclear envelope and extends in a continuous network through cytoplasm; rough due to ribosomes; proteins synthesized and shunted into the ER for packaging and transport; first step in secretory pathway
- Smooth endoplasmic reticulum (SER) – closed tubular network without ribosomes; functions in nutrient processing, synthesis, and storage of lipids

Figure 5-7

2. Golgi apparatus

- **Packages** proteins that will be secreted by cell into vesicles for export to exterior of the cell
- Modifies, stores, and packages proteins
- Consists of a stack of flattened sacs called cisternae
- Transitional vesicles from the ER containing proteins go to the Golgi apparatus for modification and maturation
- Condensing vesicles transport proteins to organelles or secretory proteins to the outside

Figure 5-8

Figure 5-9

nucleus → RER → Golgi → vesicles → secretion

3. Lysosomes and Peroxisomes

- Compartments with chemicals and lytic enzymes for digestion of protein, lipids, food particles, bacteria, cell debris
- Vesicles containing enzymes that originate from Golgi apparatus
- Involved in intracellular digestion of food particles and in protection against invading microbes

4. Vacuoles

- Storage compartments for food and wastes

5. Phagosome

- Vacuole merged with a lysosome

Figure 5-10

4. External structures

- **Flagella** Larger, more complex than prokaryotic flagella
 - Used for motility by some protozoa
- **Cilia** Shorter and more numerous than flagella
 - Motility --some protozoa
 - Entrapment of food --some protozoa

Rotifer

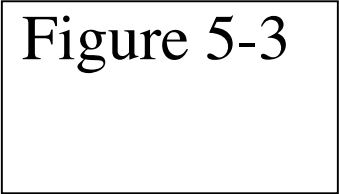


Flagella

Peranema

Peranema

Cilia



Trichonympha sp. with many long flagella. *Trichonympha*; it is a large (about 200 to 300 microns) hypermastigote

Parasitology

--The study of **Eukaryotic parasites**, their **hosts** and the **relationships** between them.

I. Terms (use malaria as an example)

- **Parasite** --organism that lives at the expense of another living organism (**host**)
 - Causes **harm** to host
 - Most are **dependent on** one or more **hosts for survival**
- **Host** --provides home and nutrients to parasite
- **Ectoparasite** --lives on **surface** of host
Ex. ticks, lice
- **Endoparasite** --live **within** host
Ex. protozoa, fungi and helminths (parasitic worms)

- **Vector** --transfers a parasite to new host
 - Ex. **Mosquito** transfers malaria parasite from 1 human to another
 - Pork** that is undercooked can transfer trichinosis worm to human
- **Reservoir** --host that usually **harbors** a parasite that is **source for transmission** to other hosts
 - Ex. Pigs are reservoirs for *Trichinella* (parasitic round worm that causes trichinosis)
- **Endemic** --organism or disease that is **always present** in a geographic location
 - Ex. Histoplasmosis
 - Fungal disease caused by *Histoplasma capsulatum*
 - Organism and disease are endemic to Ohio and Mississippi River valleys
 - Common in caves inhabited by bats

II. Effects of parasites on host

1. **Rob nutrients** –may inhibit growth and development

2. **Damage tissues**

Ex. intestines, liver, heart, brain, skin, clogged blood vessels

3. **Trigger immune response**

Ex. rash, inflammation, fever

A. Parasitic Protists (Protozoa)

Life cycles

Trophozoite

Motile feeding stage

Cyst

Resting stage formed during unfavorable conditions

Colonization of a host may be through transmission of trophozoite and/or cyst

Protozoa have diverse mechanisms for spreading to new hosts

Transmission via vectors

Transmission via ingestion by host or invasion of host tissues

A. Parasitic Protists (Protozoa)

1. **Mastigophorans** --have flagella
2. **Sarcodines** --amoeboid, indefinite shape, movement by pseudopodia (false feet)
3. **Apicomplexans** --mature form not motile, intracellular parasites

A. Parasitic Protists (Protozoa)

1. Mastigophorans --have flagella →

- *Trichomonas*

- Very common
genital tract pathogen
(Sexually transmitted)

- *Trypanosoma* spp.

- African sleeping sickness and Chagas disease
- Transmitted by tsetse fly and reduviid bug

- *Leishmania* spp.

- Fever, fatigue, diarrhea, anemia
- Transmitted by sand flies

○ *Giardia*

- Backpacker's disease, diarrhea
- Transmitted by drinking water contaminated with animal feces (e.g. beavers, cattle)

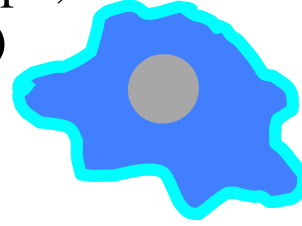
Chagas disease –American Trypanosomiasis

Parasite *Trypanosoma cruzi*

Reservoir Humans and animals

Vector Various species of reduviid bugs

2. **Sarcodines** --amoeboid, indefinite shape, movement by pseudopodia (false feet)



○ *Entamoeba histolytica*

- Amoebic dysentery: inflammation of intestines, liver abscesses
- Transmitted by food and water contaminated with feces

○ *Entamoeba gingivalis*

- Associated with periodontal disease and gingivitis

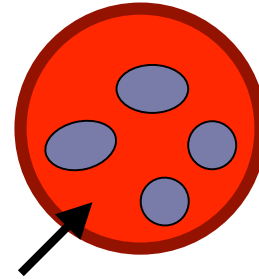
○ *Naegleria*

- Enters through nose and causes brain infections
- Free-living in warm fresh water (lakes, hot springs, hot tubs, spas)
- Accidental parasite, infection is rare

3. Apicomplexans --mature form not motile, intracellular parasites

- *Plasmodium* spp.

- **Malaria:** kills 1.5 to 3 million/year



- Inside human red blood cells during part of life cycle
- Transmitted to humans by mosquitoes

- *Toxoplasma*

- **Toxoplasmosis:** often asymptomatic but can cause hepatitis, blindness, pneumonia, neurological disorders

Ex. AIDS patients

- Transmitted by contact with feces of cats & wild animals and by eating undercooked meat
- Also transmitted across placenta to fetus causing abortion, still birth or mental and physical handicaps

Life cycle of toxoplasmosis

(Apicomplexans cont.)

○ *Cryptosporidium* spp.

Cryptosporidium parvum

- **Cryptosporidiosis** –usually mild gastrointestinal disease (diarrhea, abdominal pain, vomiting)
- Transmitted by ingestion of water contaminated with animal feces
- Large outbreak in Milwaukee, WI in 1993
 - 403,000 people infected by contaminated drinking water from one water treatment plant

B. **Fungi** (molds and yeasts)

- **Molds** have multicellular filaments called hyphae
- **Yeasts** are single-celled fungi

Mycoses are infections caused by fungi

Diseases caused by parasitic fungi

- Humans and animals

Trichophyton --skin and nail infections (athlete's foot, "ringworm")

Histoplasma --histoplasmosis, a respiratory infection

Candida --vaginal and oral yeast infections

- Plants: wilts, blights, rusts, smuts

C. Parasitic helminths (worms)

1. Flatworms

- **Flukes**

- Liver, lungs, intestinal and blood parasites
- Complex life cycle usually involving mollusks such as snails

- **Tapeworms**

- Intestinal parasites
- Human infection from eating contaminated meat

2. Roundworms

- *Trichinella* --trichinellosis, eating undercooked pork
 - Forms cysts in muscle tissue
- Heartworms --transmitted to dogs by mosquitoes
- Hookworms --intestinal parasites
-

Liver Fluke *Fasciola hepatica*

D. Arthropod (insect) parasites

- **Parasites that act as vectors** for transmission of parasitic protozoa, pathogenic bacteria and viruses while feeding on a host

Arthropod Vector	Transmitted Parasite or pathogen	Disease
1. Ticks	Various viruses <i>Borrelia burgdorferi</i> <i>Rickettsia</i>	Encephalitis, fevers Lyme disease Rocky Mt. spotted fever
2. Lice	<i>Rickettsia</i>	Typhus
3. Fleas	<i>Yersinia pestis</i>	Bubonic plague
4. Tsetse & sand flies	<i>Trypanosoma</i> <i>Leishmania</i>	African sleeping sickness Leishmaniasis
5. Mosquitos	Viruses <i>Plasmodium</i>	Encephalitis, fevers Malaria

Sand fly